

**AUTOMATIC POWER METER READING
USING GSM**

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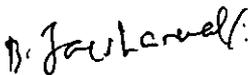
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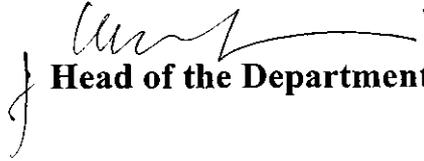
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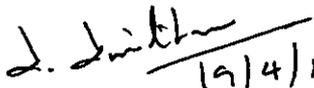
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ABSTRACT

The development of a GSM based Automated power meter reading is presented in this project. The GSM automated power meter reading system consists of GSM power meters installed in every consumer house and an electric e-billing at the energy provider side . GSM modem which utilizes the GSM network to send its power usage reading using short messaging system (SMS) back to the energy provider wirelessly.

At the power provider side an e-billing is used to manage all received SMS meter reading and the cost is computed . In case of failure to pay the bill within the due date ,The proposed project enables the facility to cut off the power to that particular consumer house automatically just by sending an SMS to that particular consumer house from the energy provider side .This project reduces the amount of work normally done by the electricity board ,where it is also more accurate and less time consuming process when compared to the normal process which involves a lot of man work.

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LIST OF ABBREVIATIONS

AMPR	-----	Automatic power meter reading
GSM	-----	Global System for Mobile
LCD	-----	Liquid Crystal Display
LED	-----	Light Emitting Diode
PCB	-----	Printed Circuit Board
PIC	-----	Peripheral Interface Controller
RISC	-----	Reduced Instruction Set Controller
RTS	-----	Real Time System
SIM	-----	Subscriber Identity Module
SMS	-----	Short Message Sending

CHAPTER -1

INTRODUCTION

1.1 INTRODUCTION

Traditional meter reading for electricity consumption and billing is done by human operator from houses to houses and building to building. This requires huge number of labour operators and long working hour to achieve complete area data reading and billing. Human operator billing or prone to reading error as sometime the houses electric power meter is place in a location where it is not easily accessible. Labour billing job is sometime also restricted and is slowed down by bad weather condition. The increase development of residential housing and commercial building in the developing country such as for example , Malaysia require more human operators and longer working hours to complete the meter reading task. This increases the energy provider operation costs for meter reading .

In order to achieve efficient meter reading, reduce billing error and operation costs, automatic meter reading (AMR) system play an important role to address the above mentioned problems To implement automatic Power meter reading for providing high flexibility, accuracy using wireless Network

GSM (Global System for Mobile communication) is a digital mobile telephone system that is widely used in Europe and other parts of the world. GSM uses a variation of Time Division Multiple Access (TDMA) and is the most widely used of the three digital wireless telephone technologies (TDMA GSM,and CDMA). It uses GSM to inform or send Message to consumer through the mobile phone

1.2 INTRODUCTION TO EMBEDDED SYSTEM

An embedded system is a specialized computer system that is part of a large system or machine. Typically, an embedded system is housed on a single microprocessor board with the programs stored in ROM. Virtually all appliances that have a digital interface, such as watches, microwaves, VCR's, cars etc.

Utilize embedded systems. Some embedded system includes an operating system, but many are so specialized that the entire logic can be implemented as a single program.

Since embedded system is dedicated to specific tasks, design engineers can optimize it reducing the size and cost of the product, or increasing the reliability and performances. Some embedded systems are mass produced, benefiting from economies of scale.

Physically, embedded system range from portable device such as digital watches and Mp4 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants.

Complexity varies from low, with a single microcontroller chip to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure.

1.2.1 CHARACTERISTICS OF EMBEDDED SYSTEMS

Embedded systems are designed to do some specific tasks, rather than be a general purpose computer for multiple tasks. Some also have real time performance constraints that must be met, for reasons such as safety and usability.

Embedded systems are not always stand alone devices. Many embedded system consist of small, computerized parts within a large device that serves more general purposes

1.2.2 USER INTERFACE

Embedded System range from no user interfaces at all dedicated only to one task, to complete graphical user interfaces that resemble modern computer desktop operating system.

1.2.3 SIMPLE SYSTEM

Simple Embedded devices use buttons, LED's and small character or digital only displays, often with simple menu systems. This is commonly used where the cost of the project is less .It can be constructed easily by using the basic components and it is also easy to understand because of the basis nature ,if there arises a need where we want to use more sophisticated designs we go for complex embedded system which is more effective in certain cases.

1.2.4 COMPLEX SYSTEM

A full graphical screen, with touch sensing - edge button provides flexibility while minimizing space used the measuring of the button can change with the screen and relation involves the natural behaviour of pointing at what is desired. Handheld systems often have a screen with a “Joystick Button” for a pointing device. The size of the World Wide Web has given Embedded designers another quite different option, providing a web page interface over a network connection.

This avoids the end of a sophisticated display, yet provides complex input and display capability when needed, on another computers. This is successful for remote, permanently installed equipment such as Pan Tilt-zoom cameras and network router.

1.2.5 EMBEDDED PROCESSOR

Embedded processor can be broken into two broad categories. Ordinary Microprocessors and Microcontrollers which have many peripheral on chip, reducing cost and size. Contrasting to the personal computer and server markets, a fairly large number of basic CPU architecture are used.

1.3 LANGUAGES USED FOR CODING

- C
- C++
- Java
- Linux

1.3.1. MPLAB Features

MPLAB Integrated Development Environment (IDE) is a free, integrated toolset for the development of embedded applications employing Microchip's PIC® and dsPIC® microcontrollers.

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MPLAB IDE runs as a 32-bit application on MS Windows®, is easy to use and includes a host of free software components for fast application development and super-charged debugging.

MPLAB IDE also serves as a single, unified graphical user interface for additional Microchip and third party software and hardware development tools. Moving between tools is a snap, and upgrading from the free software simulator to hardware debug and programming tools is done in a flash because MPLAB IDE has the same user interface for all tools.

MPLAB IDE's SIM, high speed software simulator for PIC and dsPIC (Digital Signal Processing PIC Microcontroller) devices with peripheral simulation, complex stimulus injection and register logging.

CHAPTER 2

BLOCK DIAGRAM AND DESCRIPTION

2.1 BLOCK DIAGRAM

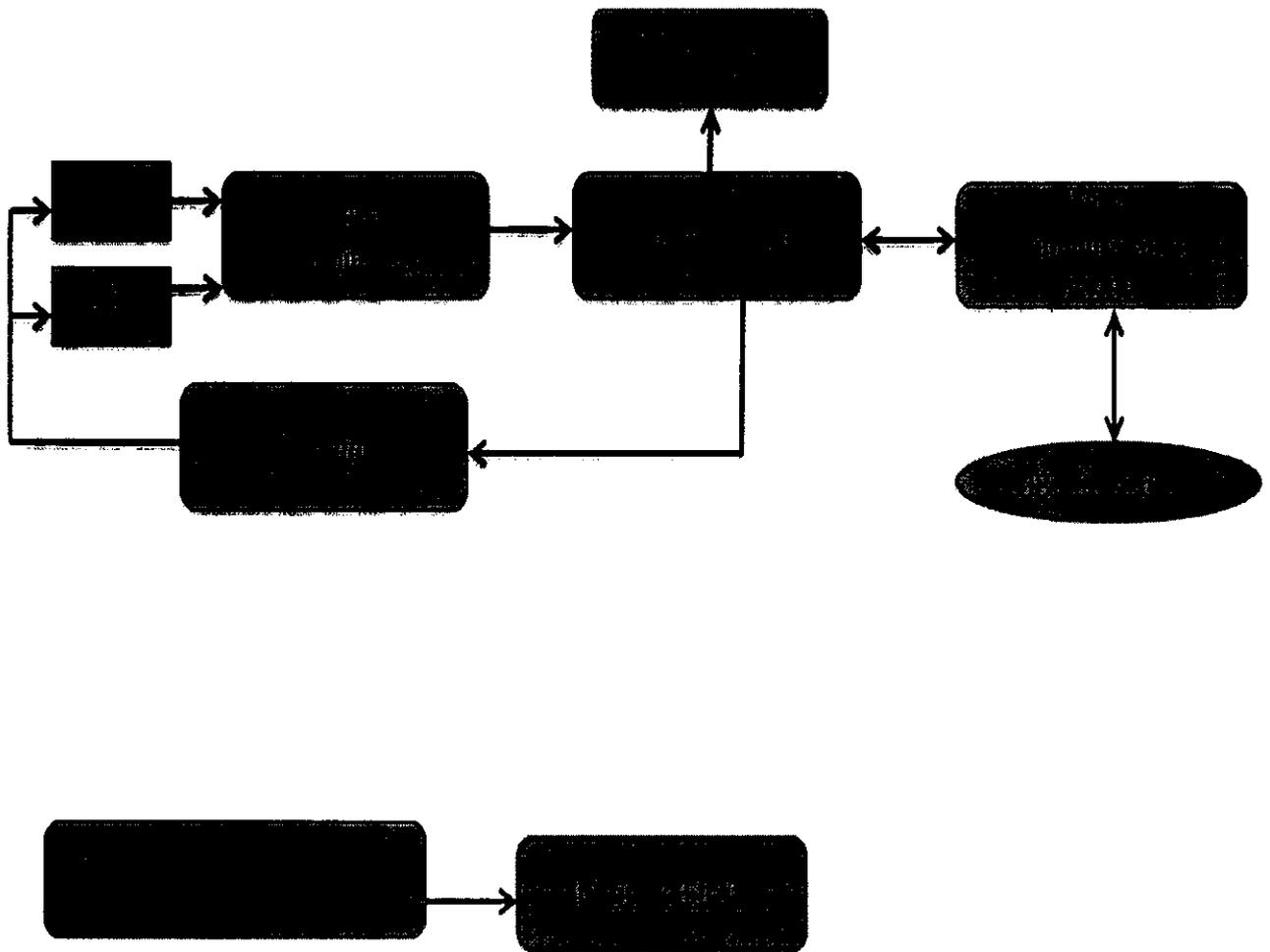


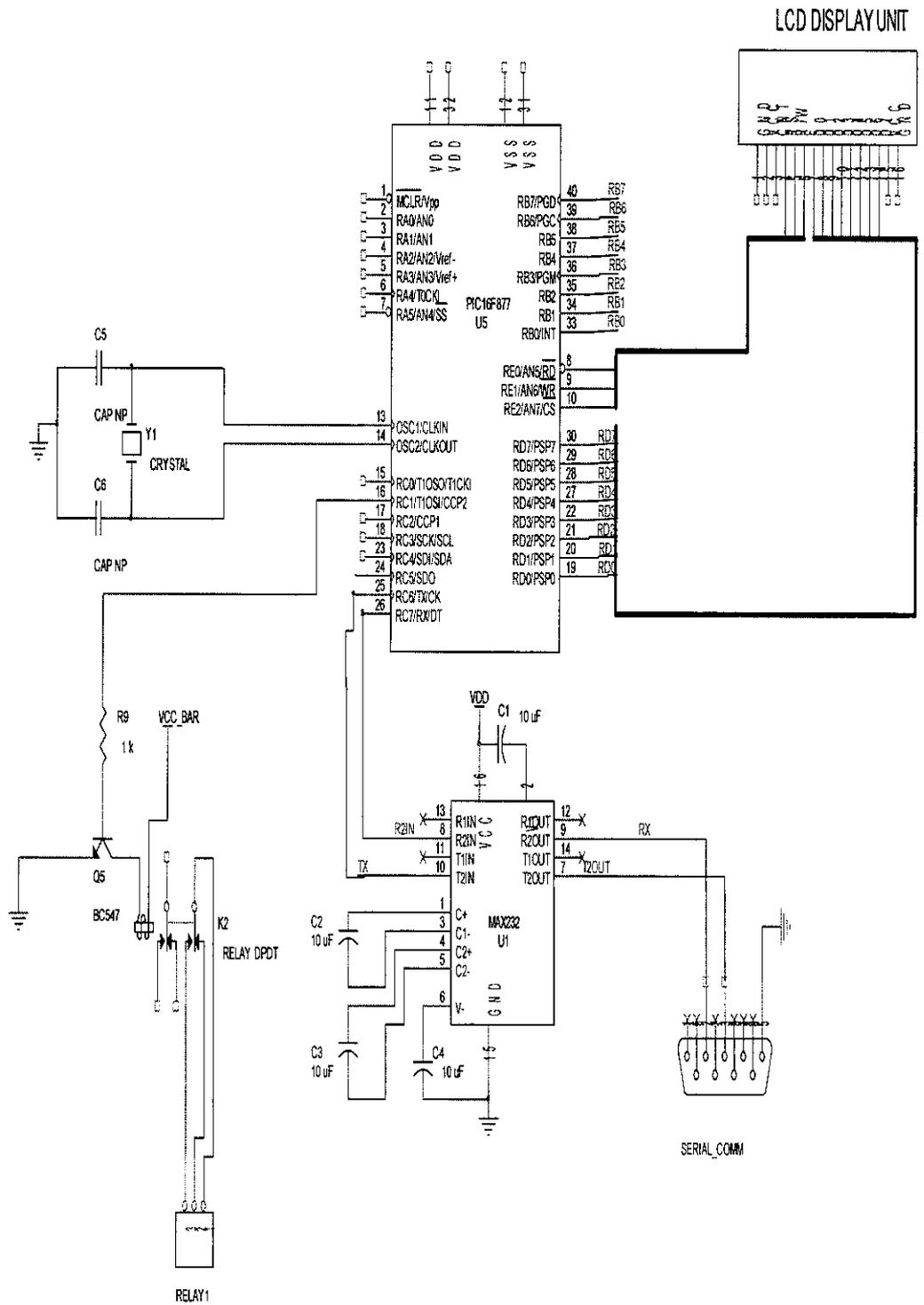
Figure 2.1 block diagram of APMR

2.2 BRIEF DESCRIPTION OF BLOCK DIAGRAM

- 1) Input power supply is given to the consumer through actuator
- 2) Actuator acts as a switch, it is controlled by microcontroller.
- 3) Current transformer and potential transformer are used to measure the power generated by means of microcontroller
- 4) Display unit is used to display meter readings and bill status
- 5) The meter reading is send to the admin center through GSM modem using serial communication
- 6) The process of serial communication is carried out by the use of RS 232 cable
- 7) In the admin center the meter readings are received by means of GSM

CHAPTER -3

CIRCUIT DIAGRAM AND DESCRIPTION



3.2. CIRCUIT OPERATION

The input to the circuit is made by means of step down transformer.the step down transformer is used to convert the 230v supply to 9v,1 amps.The Bridge rectifier is used to convert ac to dc.the voltage obtained is in the form of pulsating dc .so in order to get pure dc we are using pulsating capacitors. since only 5v is needed for the circuit, a voltage regulator is used. The power output from the load are measured by means of voltage and current transformer. The load is connected to a relay circuit which does the actuator job. The power measured is displayed by means of LCD.A circuit has been provided to stop the reverse flow of current.For this Zener diode is employed. The microcontroller is given an interrupt function. Whenever an interrupt is provided the data is transferred by means of gsm. Gsm stands for global system for mobiles. This uses a 2g band. gsm is used for both transmission and reception of data. The output obtained from the load is transferred by means of GSM. The output from microcontroller is in the form of ttl logic. so for transmission of data we have to convert into max 232 logic. So for this we are using max 232.the output is transmitted by RS 232.During reception the same max 232 logic is converted to ttl logic. A reset switch has been provided in order to reset the reading. The readings are transmitted once in 2 months. If there is delay in payment of data the power will be automatically shut down from the office. The main advantage of the project is that the consumer can know the amount of unit consumed along with usage charges.

CHAPTER -4

HARDWARE REQUIREMENTS

4.1 GSM MODEM

4.1.1 DEFINITION

Global system for mobile communication (GSM) is a globally accepted standard for digital cellular communication. GSM is the name of a standardization group established in 1982 to create a common European mobile telephone standard that would formulate specifications for a pan-European mobile cellular radio system operating at 900 MHz.

4.1.2 THE GSM NETWORK

GSM provides recommendations, not requirements. The GSM specifications define the functions and interface requirements in detail but do not address the hardware.. The GSM network is divided into three major systems: the switching system (SS), the base station system (BSS), and the operation and support system (OSS).

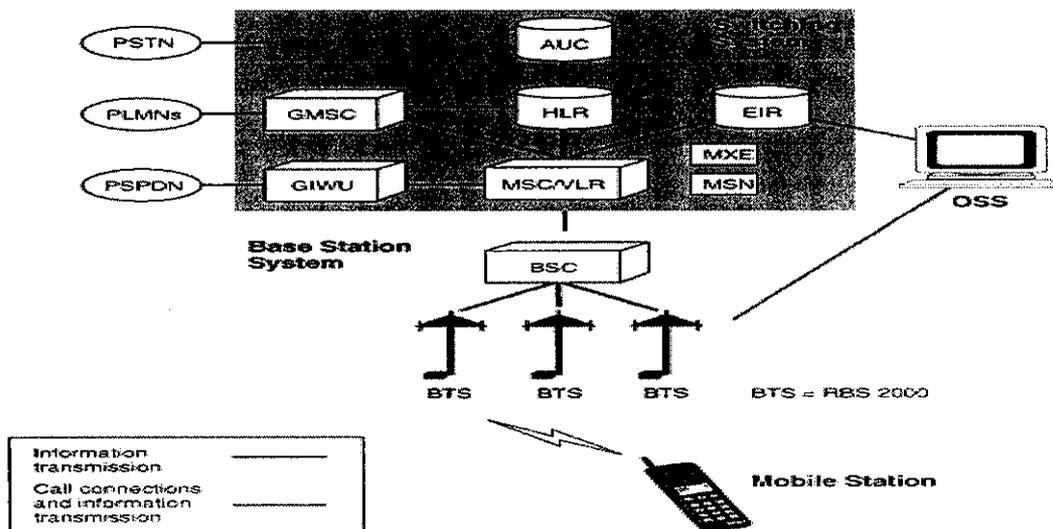


Figure 4 .2 The GSM Network

4.1.3 GSM NETWORK ELEMENTS

A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves.

A GSM modem can be an external device or a PC Card / PCMCIA Card. Typically, an external GSM modem is connected to a computer through a serial cable or a USB cable. A GSM modem in the form of a PC Card / PCMCIA Card is designed for use with a laptop computer. It should be inserted into one of the PC Card / PCMCIA Card slots of a laptop computer. Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier in order to operate.

As mentioned in earlier sections of this SMS tutorial, computers use AT commands to control modems. Both GSM modems and dial-up modems support a common set of standard AT commands. You can use a GSM modem just like a dial-up modem.

In addition to the standard AT commands, GSM modems support an extended set of AT commands. These extended AT commands are defined in the GSM standards. With the extended AT commands, you can do things like:

- Reading, writing and deleting SMS messages.
- Sending SMS messages.
- Monitoring the signal strength.
- Monitoring the charging status and charge level of the battery.
- Reading, writing and searching phone book entries.
- The number of SMS messages that can be processed by a GSM modem per minute is very low -- only about six to ten SMS messages per minute.

4.1.4 FACTS AND APPLICATIONS OF GSM/GPRS MODEM

The GSM/GPRS Modem comes with a serial interface through which the modem can be controlled using AT command interface. An antenna and a power adapter are provided. The basic segregation of working of the modem is as under

- Voice calls
- SMS
- GSM Data calls
- GPRS

4.1.5 VOICE CALLS

Voice calls are not an application area to be targeted. In future if interfaces like a microphone and speaker are provided for some applications .

4.1.6 SMS

SMS is an area where the modem can be used to provide features like:

- Pre-stored SMS transmission
- These SMS can be transmitted on certain trigger events in an automation system

SMS can also be used in areas where small text information has to be sent. The transmitter can be an automation system or where The navigator keeps on sending SMS at particular time intervals. SMS can be a solution where GSM data call or GPRS services are not available

4.1.7 APPLICATIONS SUITABLE FOR GSM COMMUNICATION

If your application needs one or more of the following features, GSM will be more cost-effective than other communication systems.

4.1.8 SHORT DATA SIZE

Your data size per transaction should be small like 1-3 lines. e.g. banking transaction data, sales/purchase data, consignment tracking data, updates. These small but important transaction data can be sent through SMS messaging which cost even less than a local telephone call or sometimes free of cost worldwide. Hence with negligible cost you are able to send critical information to your head office located anywhere in the world from multiple points.

You can also transfer faxes, large data through GSM but this will be as or more costly compared to landline networks.

4.1.9 MULTIPLE REMOTE DATA COLLECTION POINTS

If you have multiple data collection points situated all over your city, state, country or worldwide you will benefit the most. The data can be sent from multiple points like your branch offices, business associates, warehouses, and agents with devices like GSM modems connected to PCs, GSM electronic terminals and Mobile phones. Many a times some places like warehouses may be situated at remote location may not have landline or internet but you will have GSM network still available easily.

4.2 HIGH UPTIME

If your business require high uptime and availability GSM is best suitable for you as GSM mobile networks have high uptime compared to landline, internet and other communication mediums. Also in situations where you expect that someone may sabotage your communication systems by cutting wires or taping landlines, you can. Depend on GSM wireless transmission.

4.2.1 LARGE TRANSACTION VOLUMES

GSM SMS messaging can handle large number of transaction in a very short time. You can receive large number SMS messages on your server like e-mails without internet connectivity. E-mails normally get delayed a lot but SMS messages are almost instantaneous for instant transactions. Consider situation like shop owners doing credit card transaction with GSM technology instead of conventional landlines. time you find local transaction servers busy as these servers use multiple telephone lines to take care of multiple transactions, whereas one GSM connection is enough to handle hundreds of transaction.

4.2.2 MOBILITY, QUICK INSTALLATION

GSM technology allows mobility, GSM terminals, modems can be just picked and installed at other location unlike telephone lines. This is normally quicly done unlike other networks because of easy mobility of the equipments

4.3.1 Pin diagram of micro controller

Pin Diagram

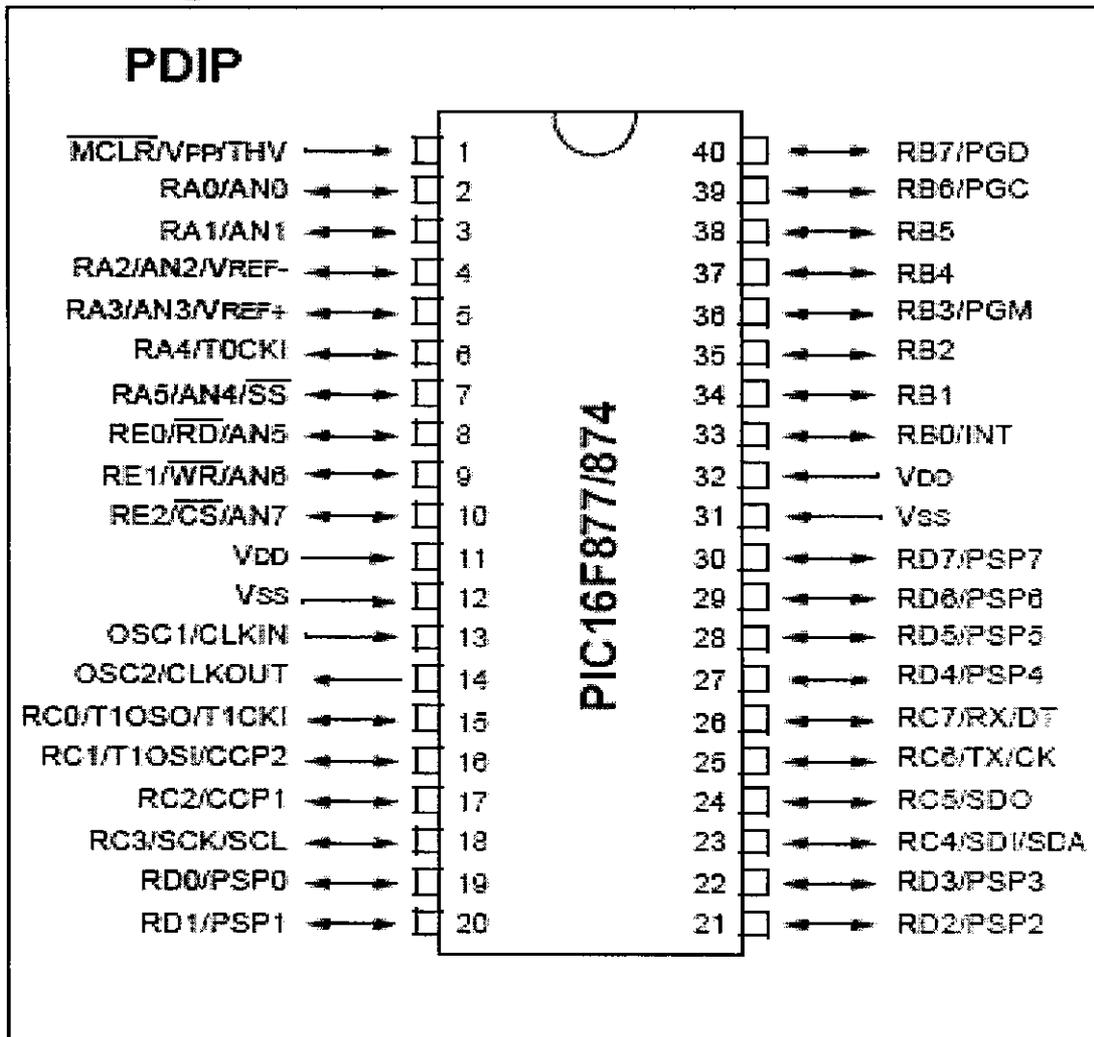


Figure 4.3.1 Pin diagram of PIC16F87X

4.3.2 MICROCONTROLLER CORE FEATURES

1. High-performance RISC CPU.
2. Only 35 single word instructions to learn.
3. All single cycle instructions except for program branches which are two cycle
4. Operating speed: DC - 20 MHz clock input DC - 200 ns instruction cycle
5. Up to 8K x 14 words of FLASH Program Memory, Up to 368 x 8 bytes of Data Memory (RAM) Up to 256 x 8 bytes of EEPROM data memory.
6. Pinout compatible to the PIC16C73B/74B/76/77.
 - Interrupt capability (up to 14 sources).
 - Eight level deep hardware stack.
 - Direct, indirect and relative addressing modes.
 - Power-on Reset (POR).
 - Power-up Timer (PWRT) and Oscillator Start-up Timer (OST).
 - Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation.
 - Programmable code-protection.
 - Power saving SLEEP mode.
 - Selectable oscillator options.
 - Low-power, high-speed CMOS FLASH/EEPROM technology.
 - Fully static design.
7. In-Circuit Serial Programming (ICSP) via two pins.

- Single 5V In-Circuit Serial Programming capability.
- In-Circuit Debugging via two pins.
- Processor read/write access to program memory.
- Wide operating voltage range: 2.0V to 5.5V.
- High Sink/Source Current: 25 mA.
- Commercial and Industrial temperature ranges.
- Low-power consumption.
- - < 2 mA typical @ 5V, 4 MHz
- - 20 μ A typical @ 3V, 32 kHz
- - < 1 μ A typical standby current.

4.3.3 PERIPHERAL FEATURES

- Timer0: 8-bit timer/counter with 8-bit prescaler
- Timer1: 16-bit timer/counter with prescaler, Can be incremented during sleep via external Crystal/clock.
- Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler.
- Two Capture, Compare, PWM modules
- Capture is 16-bit, max. resolution is 12.5 ns
- Compare is 16-bit, max. resolution is 200 ns

- PWM max. resolution is 10-bit
- 10-bit multi-channel Analog-to-Digital converter
- Synchronous Serial Port (SSP) with SPI□□(Master Mode) and I2C□□(Master/Slave)
- Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9-bit address detection.
- Parallel Slave Port (PSP) 8-bits wide, with external RD, WR and CS controls (40/44-pin only) Brown-out detection circuitry for Brown-out

Table 3.1 peripheral Features

Key Features PICmicro™ Mid-Range Reference Manual (DS33023)	PIC16F873	PIC16F874	PIC16F876	PIC16F877
Operating Frequency	DC - 20 MHz			
Resets (and Delays)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)
FLASH Program Memory (14-bit words)	4K	4K	8K	8K
Data Memory (bytes)	192	192	368	368
EEPROM Data Memory	128	128	256	256
Interrupts	13	14	13	14
I/O Ports	Ports A,B,C	Ports A,B,C,D,E	Ports A,B,C	Ports A,B,C,D,E
Timers	3	3	3	3
Capture/Compare/PWM modules	2	2	2	2
Serial Communications	MSSP, USART	MSSP, USART	MSSP, USART	MSSP, USART
Parallel Communications	—	PSP	—	PSP
10-bit Analog-to-Digital Module	5 input channels	8 input channels	5 input channels	8 input channels
Instruction Set	35 Instructions	35 Instructions	35 Instructions	35 Instructions

4.3.4 DEVICE OVERVIEW

This document contains device-specific information. Additional information may be found in the PICmicro™ Mid-Range Reference Manual, (DS33023), which may be obtained from your local Microchip Sales Representative or downloaded from the Microchip website. The Reference Manual should be considered a complementary document to this data sheet, and is highly recommended reading for a better understanding of the device architecture and operation of the peripheral modules. There are four devices (PIC16F873, PIC16F874, PIC16F876 and PIC16F877) covered by this data sheet. The PIC16F876/873 devices come in 28-pin packages and the PIC16F877/874 devices come in 40-pin packages. The 28-pin devices do not have a Parallel Slave Port implemented. The following two figures are device block diagrams sorted by pin number; 28-pin for Figure 1-1 and 40-pin for Figure 1-2. The 28-pin and 40-pin pinouts are listed in Table 1-1 and Table 1-2, respectively.

Device	Program FLASH	Data Memory	Data EEPROM
PIC16F873	4K	192 Bytes	128 Bytes
PIC16F876	8K	368 Bytes	256 Bytes

4.3.5 MEMORY ORGANISATION

There are three memory blocks in each of these PICmicro MCUs. The Program Memory and Data Memory have separate buses so that concurrent access can occur and is detailed in this section. Additional information on device memory may be found in the PIC micro□□Mid-Range Reference Manual.

4.3.6 PROGRAM MEMORY ORGANIZATION

The PIC16F87X devices have a 13-bit program counter capable of addressing an 8K x 14 program memory space. The PIC16F877/876 devices have 8K x 14 words of FLASH program memory and the PIC16F873/874 devices have 4K x 14. Accessing a location above the physically implemented address will cause a wraparound. The reset vector is at 0000h and the interrupt vector is at 0004h.

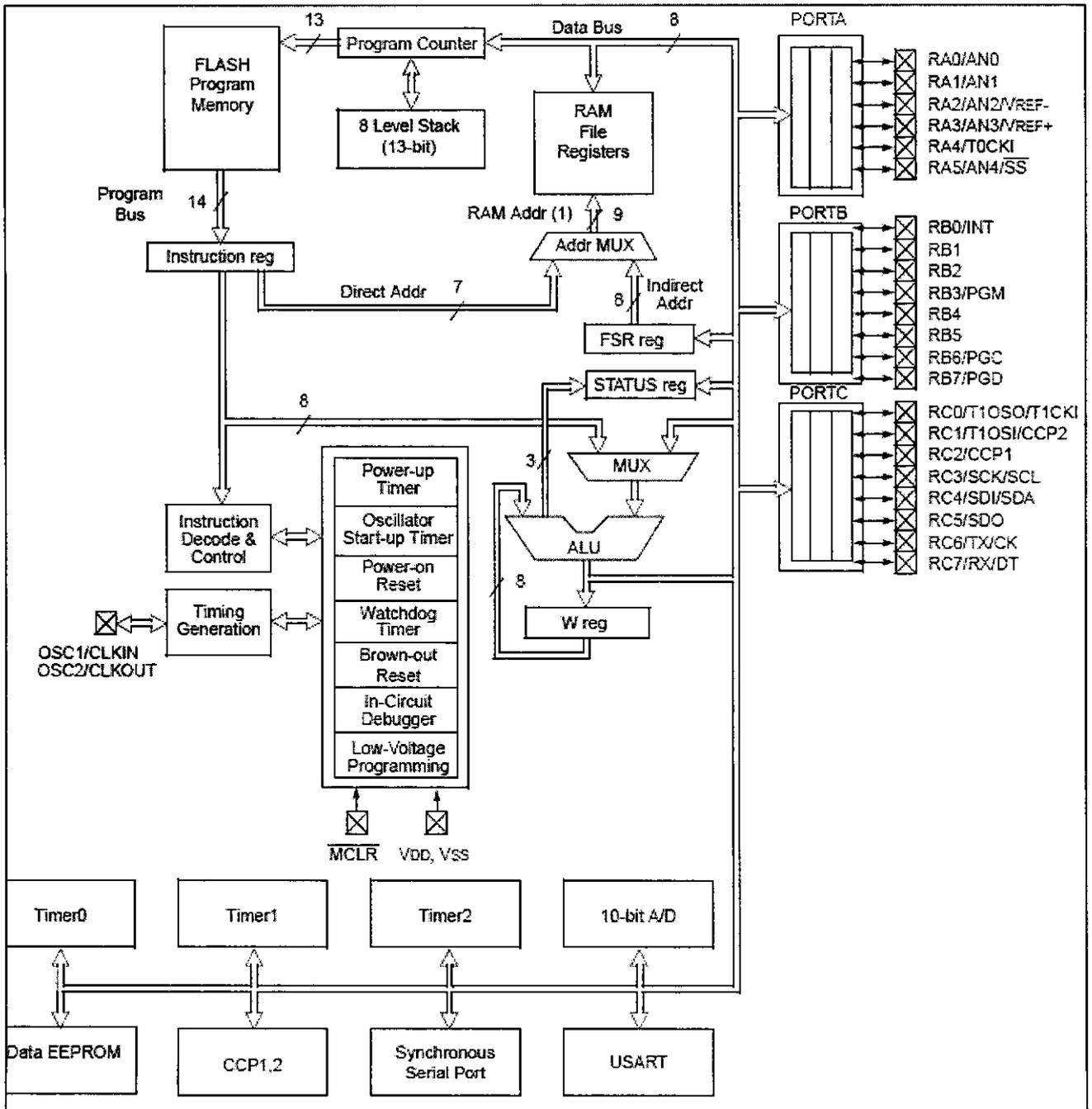


Figure 4.3.7 Architecture of PIC16F87X

4.3.8 PIC16F877/876 PROGRAM MEMORY MAP AND STACK

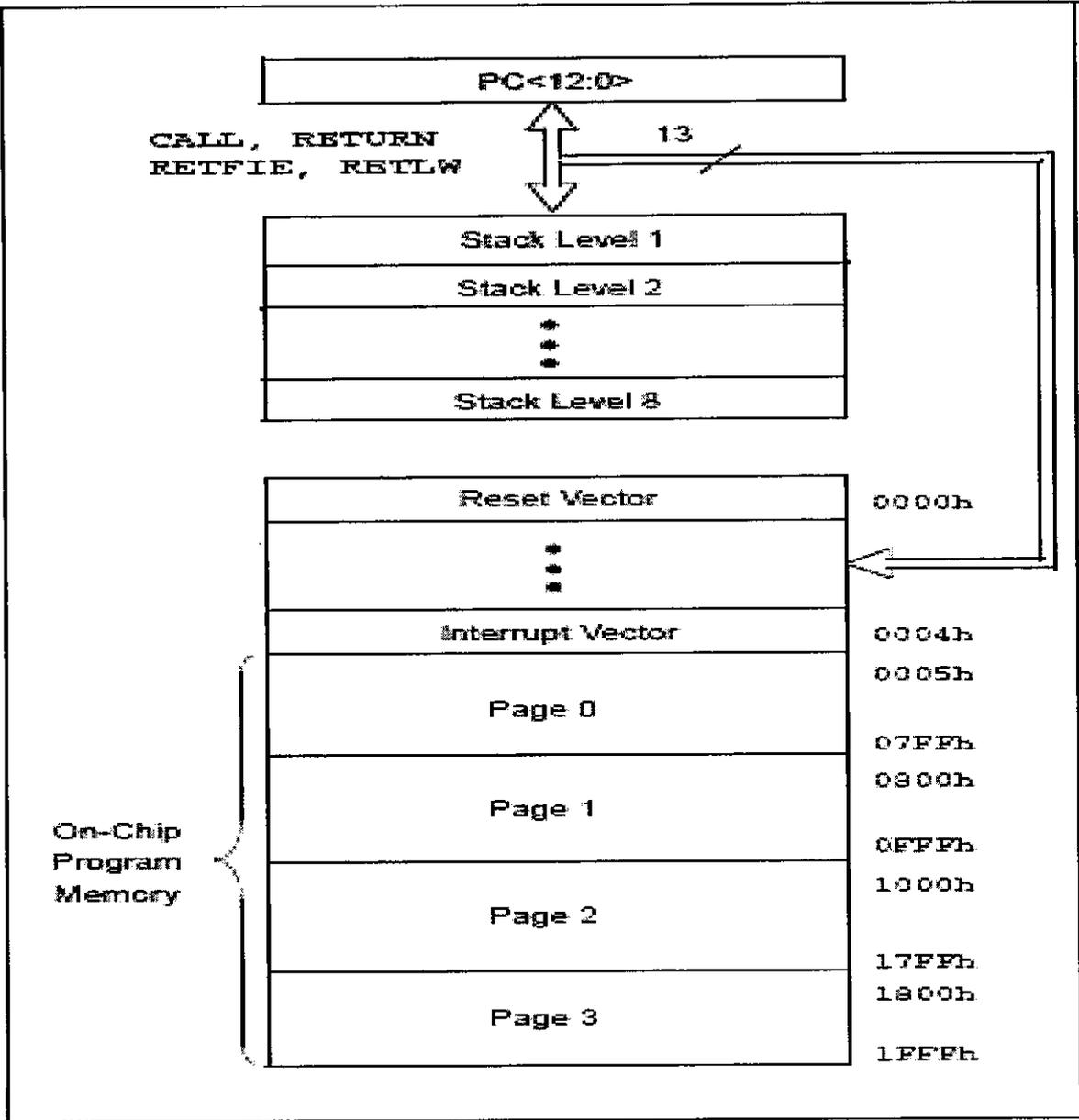


Figure 4.3.8 PIC16F877 / 876 Program memory Map and Stack

4.3.9 DATA MEMORY ORGANIZATION

The data memory is partitioned into multiple banks which contain the General Purpose Registers and the Special Function Registers. Bits RP1 (STATUS<6>) and RP0 (STATUS<5>) are the bank select bits.

RP1:RP0	Bank
00	0
01	1
10	2
11	3

Table 3.2 Data memory Organization

Each bank extends up to 7Fh (128 bytes). The lower locations of each bank are reserved for the Special Function Registers. Above the Special Function Registers are General Purpose Registers, implemented as static RAM. All implemented banks contain Special Function Registers. Some “high use” Special Function Registers from one bank may be mirrored in another bank for code reduction and quicker access.

4.4 SPECIAL FUNCTION REGISTERS

The Special Function Registers are registers used by the CPU and peripheral modules for controlling the desired operation of the device. These registers are implemented as static RAM. A list of these registers is given in Table

The Special Function Registers can be classified into two sets; core (CPU) and peripheral. Those registers associated with the core functions are described in detail in this section. Those related to the operation of the peripheral features are described in detail in the peripheral feature section.

4.4.1 SPECIAL FUNCTION REGISTER SUMMARY

Legend: x = unknown, u = unchanged, q = value depends on condition, - = unimplemented read as '0', r = reserved.

Shaded locations are unimplemented, read as '0'.

Note 1: The upper byte of the program counter is not directly accessible. PCLATH is a holding register for the PC<12:8> whose contents are transferred to the upper byte of the program counter.**2:** Other (non power-up) resets include external reset through MCLR and Watchdog Timer Reset.**3:** Bits PSPIE and PSPIF are reserved on the 28-pin devices; always maintain these bits clear.**4:** These registers can be addressed from any bank.**5:** PORTD, PORTE, TRISD, and TRISE are not physically implemented on the 28-pin devices, read as '0'.**6:** PIR2<6> and PIE2<6> are reserved on these devices; always maintain these bits clear.

4.4.2 STATUS REGISTER

The STATUS register contains the arithmetic status of the ALU, the RESET status and the bank select bits for data memory. The STATUS register can be the destination for any instruction, as with any other register. If the STATUS register is the destination for an instruction that affects the Z, DC or C bits, then the write to these three bits is disabled. These bits are set or cleared according to the device logic. Further, the TO and PD bits are not writable, therefore, the result of an instruction with the STATUS register as destination may be different. For eg, CLRF STATUS will clear the upper-three bits and set the Z bit. This leaves the STATUS register as 000u u1uu (where u = unchanged). It is recommended, therefore, that only BCF, BSF, SWAPF and MOVWF instructions are used to alter the STATUS register, because these instructions do not affect the Z, C or DC bits from the STATUS register.

4.5 ADC MODULE

ADC module is a 10-bit analog-to-digital converter. The analog circuits of this converter, referred to as the core in this document, include the front-end analog multiplexers (MUXs), sample-and-hold (S/H) circuits, the conversion registers. It includes programmable conversion sequencer, result

4.5.1 BLOCK DIAGRAM OF ADC

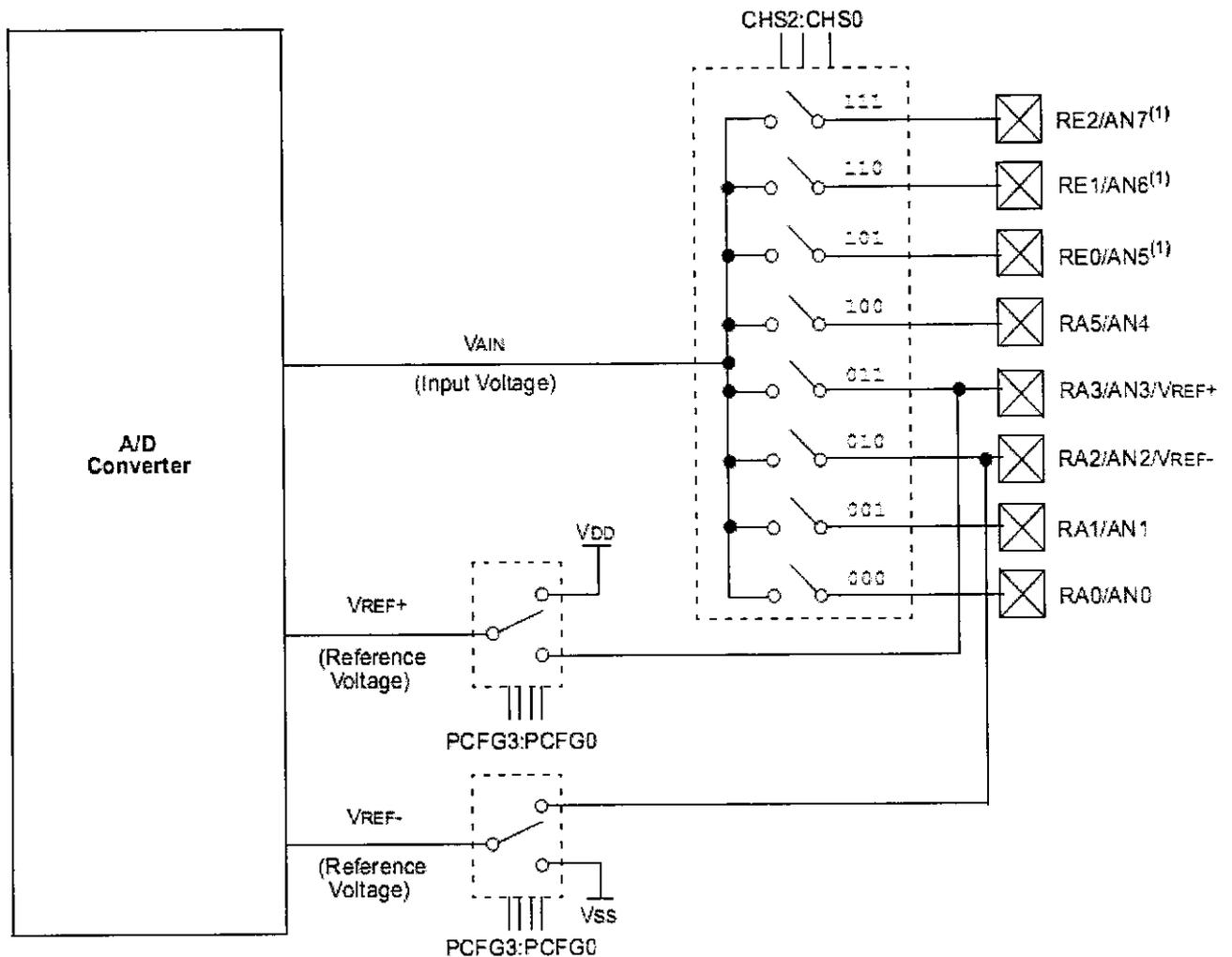


Figure 4.5 Block diagram of ADC Module

4.5.2 BLOCK EXPLANATION

The conversion technique based on a successive-approximation register (SAR), also known as bit-weighting conversion, employs a comparator to weigh the applied input voltage against the output of an N-bit digital-to-analog converter (DAC). Using the DAC output as a reference, this process approaches the final result as a sum of N weighting steps, in which each step is a single-bit conversion.

Initially all bits of SAR are set to 0. Then, beginning with the most significant bit, each bit is set to 1 sequentially. If the DAC output does not exceed the input signal voltage, the bit is left as a 1. Otherwise it is set back to 0. It is kind of a binary search. For an n -bit ADC, n steps are required.

4.5.3 DETAILS ABOUT PIC16F877A-ADC

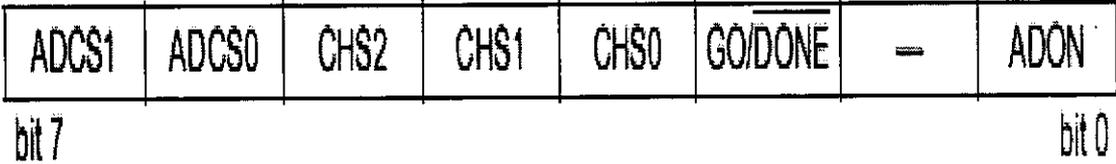
Conversion of an analog input signal results in a corresponding 10-bit digital number. The A/D module has high and low-voltage reference input that is software selectable to some combination of VDD, VSS, RA2 or RA3. The A/D module has four registers. These registers are:

- A/D Result High Register (ADRESH)
- A/D Result Low Register (ADRESL)
- A/D Control Register 0 (ADCON0)
- A/D Control Register 1 (ADCON1)

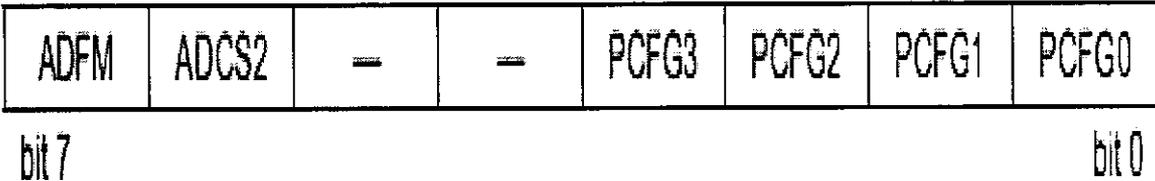
The ADCON0 register controls the operation of the A/D module.

The ADCON1 register configures the functions of the port pins. The port pins can be configured as analog inputs (RA3 can also be the voltage reference) or as digital I/O.

ADCON 0 REGISTER



ADCON 1 REGISTER



4.6 POWER SUPPLY

4.6.1 BLOCK DIAGRAM OF POWER SUPPLY

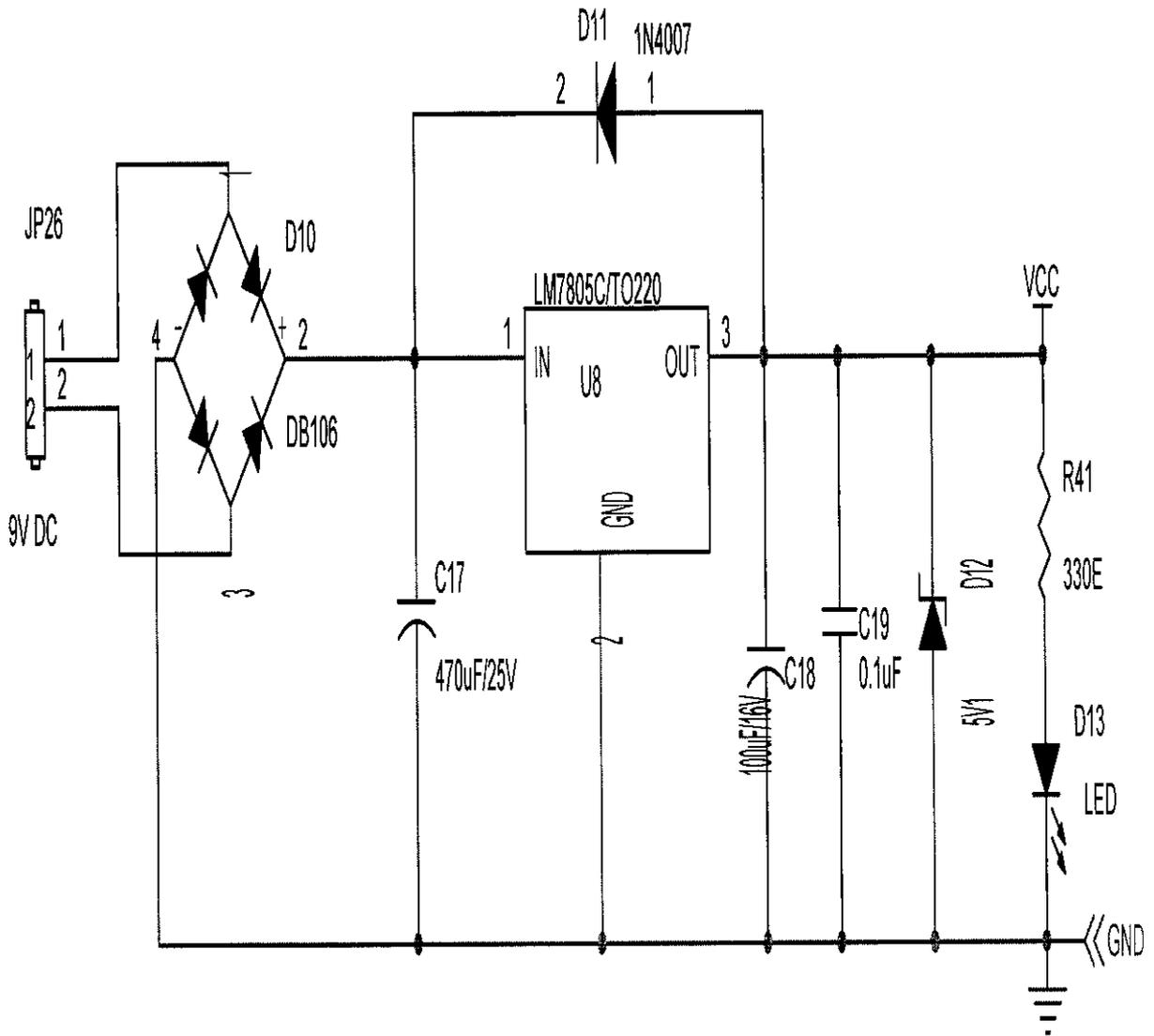


Figure 4.6 Block diagram of power supply

4.6.2 POWER SUPPLY CIRCUIT DESCRIPTION

The ac voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

4.6.3 WORKING PRINCIPLE

4.6.4 Transformer

The potential transformer will step down the power supply voltage (0-230V) to (0-6V) level. Then the secondary of the potential transformer will be connected to the precision rectifier, which is constructed with the help of op-amp. The advantages of using precision rectifier are it will give peak voltage output as DC, rest of the circuits will give only RMS output.

4.6.5 Bridge rectifier

When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners.

Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B. the positive potential at point A will forward bias D3 and reverse bias D4.

The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow.

The path for current flow is from point B through D1, up through RL, through D3, through the secondary of the transformer back to point B. this path is indicated by the solid arrows. Waveforms (1) and (2) can be observed across D1 and D3.

One-half cycle later the polarity across the secondary of the transformer reverse, forward biasing D2 and D4 and reverse biasing D1 and D3. Current flow will now be from point A through D4, up through RL, through D2, through the secondary of T1, and back to point A. This path is indicated by the broken arrows. Waveforms (3) and (4) can be observed across D2 and D4. The current flow through RL is always in the same direction

In flowing through RL this current develops a voltage corresponding to that shown waveform (5). Since current flows through the load (RL) during both half cycles of the applied voltage, this bridge rectifier is a full-wave rectifier.

One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional full-wave circuit.

This may be shown by assigning values to some of the components shown in views A and B. assume that the same transformer is used in both circuits. The peak voltage developed between points X and y is 1000 volts in both circuits. In the conventional full-wave circuit shown—in view A,

the peak voltage from the center tap to either X or Y is 500 volts. Since only one diode can conduct at any instant, the maximum voltage that can be rectified at any instant is 500 volts.

The maximum voltage that appears across the load resistor is nearly-but never exceeds-500 volts, as result of the small voltage drop across the diode. In the bridge rectifier shown in view B, the maximum voltage that can be rectified is the full secondary voltage, which is 1000 volts. Therefore, the peak output voltage across the load resistor is nearly 1000 volts. With both circuits using the same transformer, the bridge rectifier circuit produces a higher output voltage than the conventional full-wave rectifier circuit.

4.6.6 IC voltage regulator

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage.

The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts.

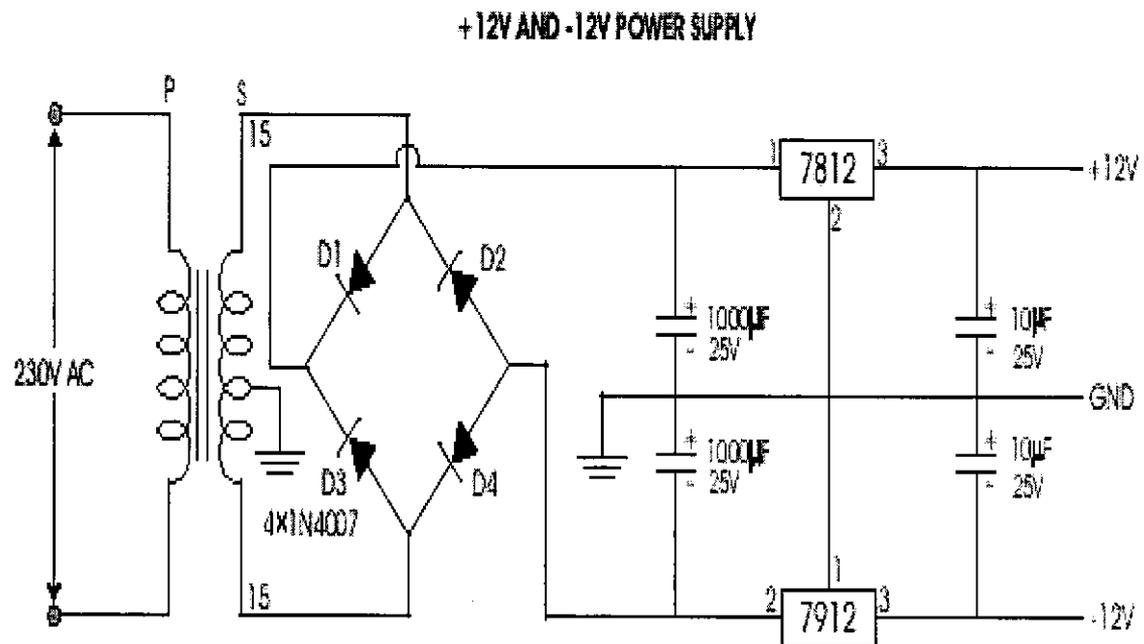
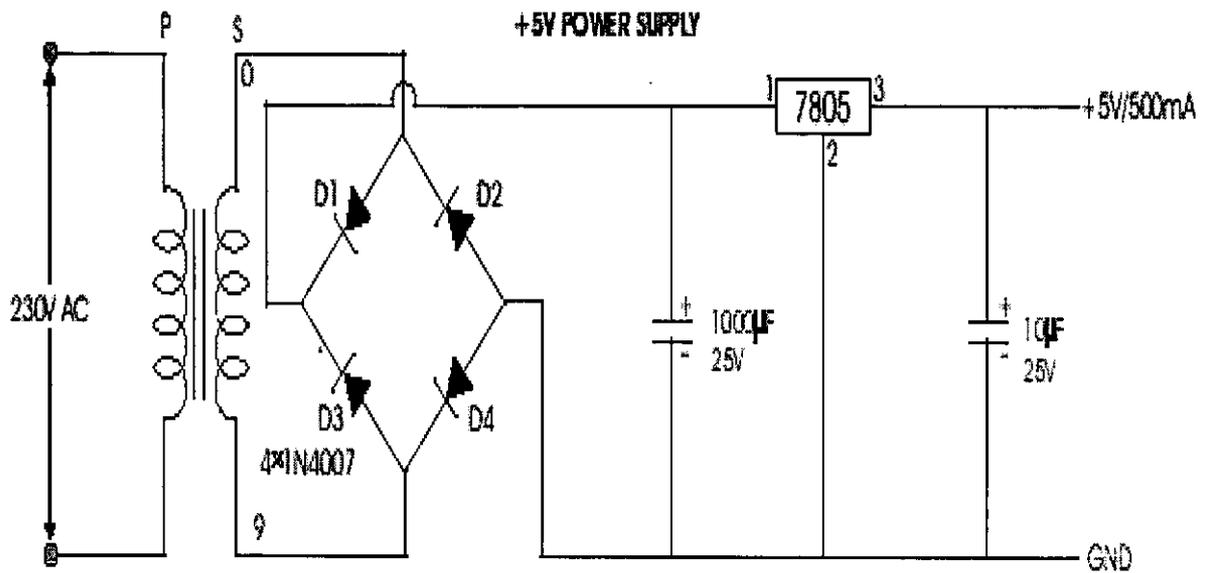
4.6.7 CIRCUIT DIAGRAM OF POWER SUPPLY

A fixed three-terminal voltage regulator has an unregulated dc input voltage, V_i , applied to one input terminal, a regulated dc output voltage, V_o , from a second terminal, with the third terminal connected to ground.

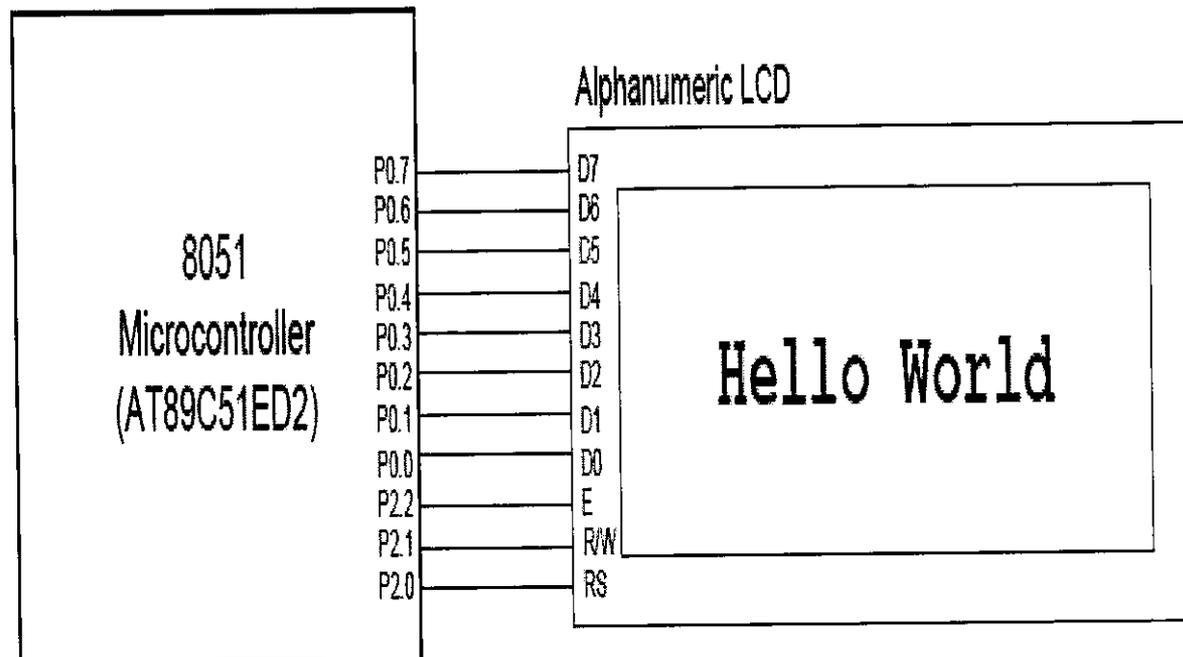
The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts.

- For ICs, microcontroller, LCD ----- 5 volts
- For alarm circuit, op-amp, relay circuits ----- 12 volts

Figure 4.6.7 Diagram Of Power Supply



4.7.3 LCD INTERFACING WITH MICROCONTROLLER



LCD INSTRUCTIONS

- Clear Display
- Return Home
- Entry Mode Set
- Display On/Off Control
- Cursor or Display Shift
- Set line address

4.8 SERIAL COMMUNICATION

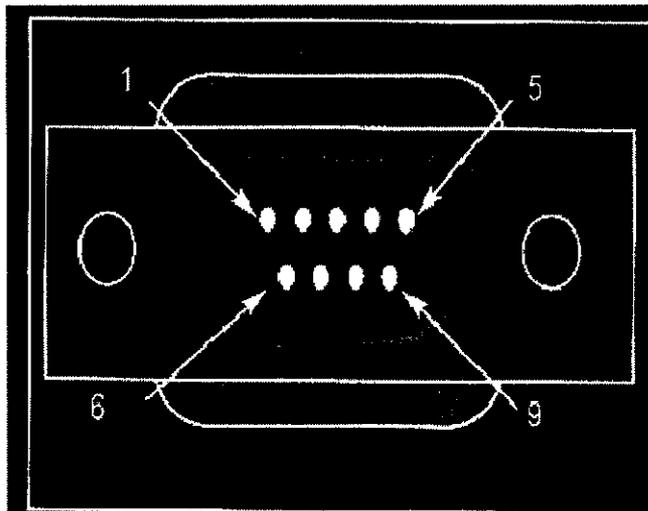


Figure 10-5. DB-9 9-Pin Connector

Table 10-2: IBM PC DB-9 Signals

Pin	Description
1	Data carrier detect (\overline{DCD})
2	Received data (RxD)
3	Transmitted data (TxD)
4	Data terminal ready (DTR)
5	Signal ground (GND)
6	Data set ready (\overline{DSR})
7	Request to send (RTS)
8	Clear to send (\overline{CTS})
9	Ring indicator (RI)

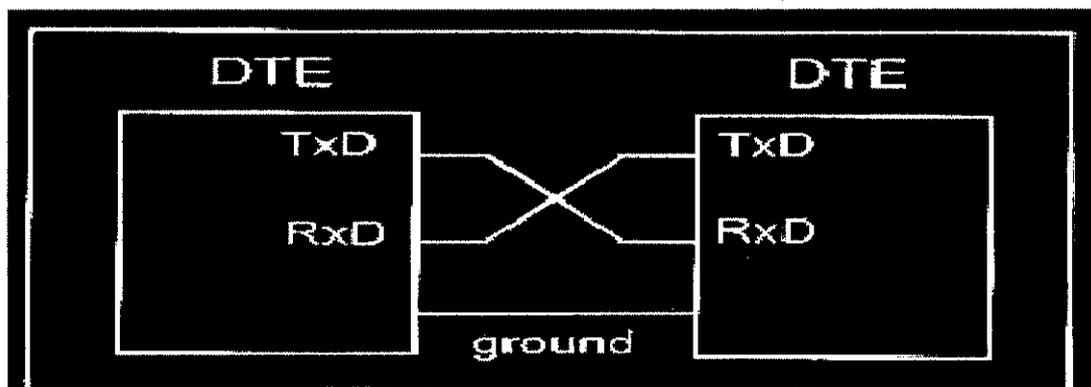


Figure 10-6. Null Modem Connection

Figure 4.8.1 RS232 Pins

4.8.2 DESCRIPTION OF SERIAL COMMUNICATION

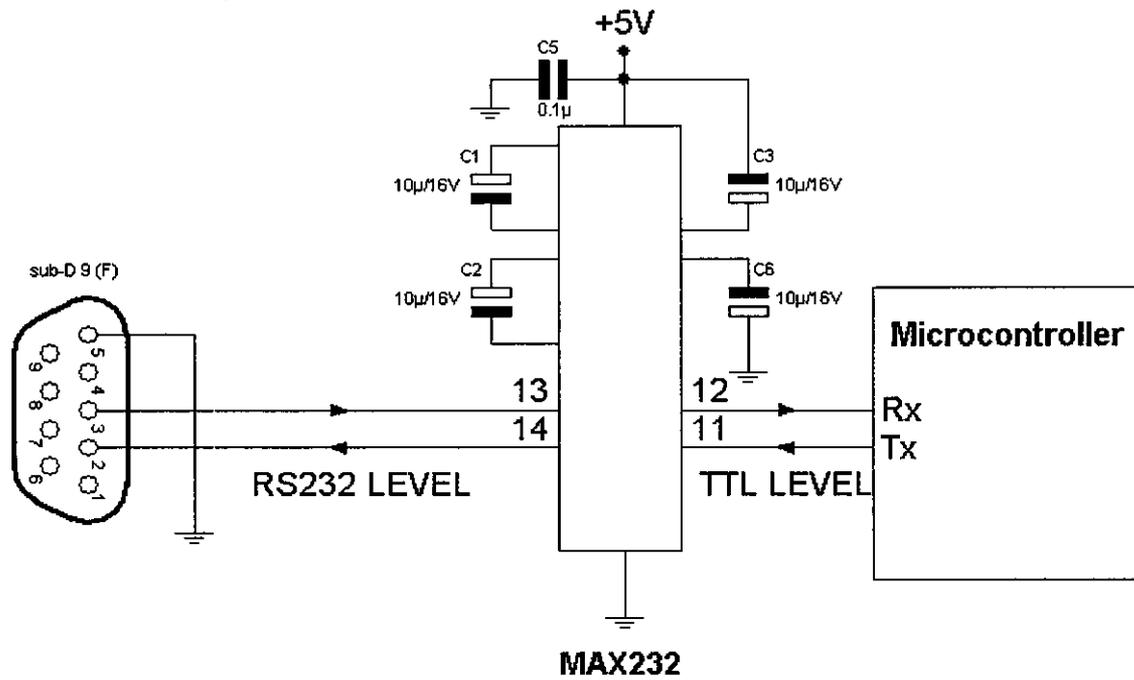
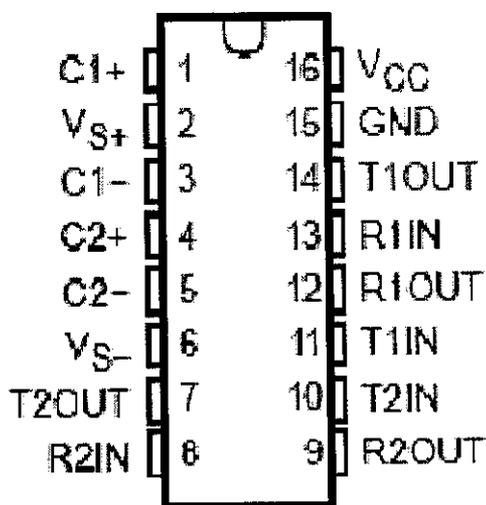


Figure 4. 9 Description of Serial connection

4.8.3 INTRODUCTION OF MAX232

MAX-232 is primary used for people building electronics with an RS-232 interface. Serial RS-232 communication works with voltages (-15V ... -3V for high) and +3V ... +15V for low) which are not compatible with normal computer logic voltages. To receive serial data from an RS-232 interface the voltage has to be reduced, and the low and high voltage level inverted. In the other direction (sending data from some logic over RS-232) the low logic voltage has to be "bumped up", and a negative voltage has to be generated, too.

RS-232	TTL	Logic
-15V ... -3V	<-> +2V ... +5V	<-> high
+3V ... +15V	<-> 0V ... +0.8V	<-> low



4.8.4 INTRODUCTION TO RS232 COMMUNICATION

Serial communication is basically the transmission or reception of data one bit at a time. Today's computers generally address data in bytes or some multiple thereof. A byte contains 8 bits. A bit is basically either a logical 1 or zero. Every character on this page is actually expressed internally as one byte. The serial port is used to convert each byte to a stream of ones and zeroes as well as to convert a streams of ones and zeroes to bytes. The serial port contains a electronic chip called a **Universal Asynchronous Receiver/Transmitter (UART)** that actually does the conversion.

The serial port has many pins. We will discuss the transmit and receive pin first. Electrically speaking, whenever the serial port sends a logical one (1) a negative voltage is effected on the transmit pin. Whenever the serial port sends a logical zero (0) a positive voltage is effected. When no data is being sent, the serial port's transmit pin's voltage is negative (1) and is said to be in a **MARK** state. Note that the serial port can also be forced to keep the transmit pin at a positive voltage (0) and is said to be the **SPACE** or **BREAK** state. (The terms **MARK** and **SPACE** are also used to simply denote a negative voltage (1) or a positive voltage(0) at the transmit pin respectively).

When transmitting a byte, the UART (serial port) first sends a **START BIT** which is a positive voltage (0), followed by the data (general 8 bits, but could be 5, 6, 7, or 8 bits) followed by one or two **STOP BITs** which is a negative(1) voltage. The sequence is repeated for each byte sent. **Figure 1** shows a diagram of a what a byte transmission would look like.

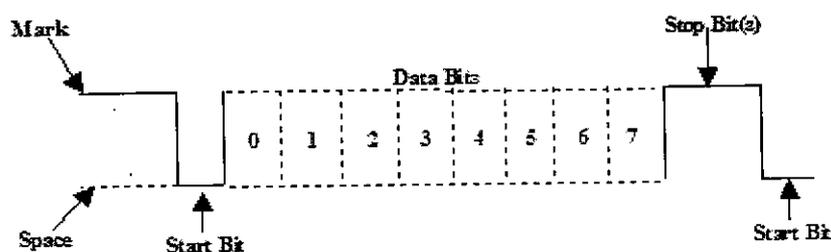


Figure 1

At this point you may want to know what is the duration of a bit. In other words, how long does the signal stay in a particular state to define a bit. The answer is simple. It is dependent on the baud rate. The baud rate is the number of times the signal can switch states in one second. Therefore, if the line is operating at 9600 baud, the line can switch states 9,600 times per second. This means each bit has the duration of $1/9600$ of a second or about 100 μ sec.

When transmitting a character there are other characteristics other than the baud rate that must be known or that must be setup. These characteristics define the entire interpretation of the data stream.

The first characteristic is the length of the byte that will be transmitted. This length in general can be anywhere from 5 to 8 bits.

The second characteristic is parity. The parity characteristic can be even, odd, mark, space, or none. If even parity, then the last data bit transmitted will be a logical 1 if the data transmitted had an even amount of 0 bits. If odd parity, then the last data bit transmitted will be a logical 1 if the data transmitted had an odd amount of 0 bits. If **MARK** parity, then the last transmitted data bit will always be a logical 1. If **SPACE** parity, then the last transmitted data bit will always be a logical 0. If no parity then there is no parity bit transmitted.

The third characteristic is the amount of stop bits. This value in general is 1 or 2.

Assume we want to send the letter 'A' over the serial port. The binary representation of the letter 'A' is 01000001. Remembering that bits are transmitted from least significant bit (LSB) to most significant bit (MSB), the bit stream transmitted would be as follows for the line characteristics 8 bits, no parity, 1 stop bit, 9600 baud.

LSB (0 1 0 0 0 0 1 0 1) MSB

The above represents (Start Bit) (Data Bits) (Stop Bit)

To calculate the actual byte transfer rate simply divide the baud rate by the number of bits that must be transferred for each byte of data. In the case of the above example, each character requires 10 bits to be transmitted for each character. As such, at 9600 baud, up to 960 bytes can be transferred in one second.

The above discussion was concerned with the "electrical/logical" characteristics of the data stream. We will expand the discussion to line protocol.

Serial communication can be half duplex or full duplex. Full duplex communication means that a device can receive and transmit data at the same time. Half duplex means that the device cannot send and receive at the same time. It can do them both, but not at the same time. Half duplex communication is all but outdated except for a very small focused set of applications.

Half duplex serial communication needs at a minimum two wires, signal ground and the data line. Full duplex serial communication needs at a minimum three wires, signal ground, transmit data line, and receive data line. The RS232 specification governs the physical and electrical characteristics of serial communications. This specification defines several additional signals that are asserted (set to logical 1) for information and control beyond the data signals and signal ground.

These signals are the Carrier Detect Signal (CD), asserted by modems to signal a successful connection to another modem, Ring Indicator (RI), asserted by modems

to signal the phone ringing, Data Set Ready (DSR), asserted by modems to show their presence, Clear To Send (CTS), asserted by modems if they can receive data, Data Terminal Ready (DTR), asserted by terminals to show their presence, Request To Send (RTS), asserted by terminals if they can receive data. The section RS232 Cabling describes these signals and how they are connected.

The above paragraph eluded to hardware flow control. Hardware flow control is a method that two connected devices use to tell each other electronically when to send or when not to send data. A modem in general drops (logical 0) its CTS line when it can no longer receive characters. It re-asserts it when it can receive again. A terminal does the same thing instead with the RTS signal. Another method of hardware flow control in practice is to perform the same procedure in the previous paragraph except that the DSR and DTR signals are used for the handshake.

Note that hardware flow control requires the use of additional wires. The benefit to this however is crisp and reliable flow control. Another method of flow control used is known as software flow control. This method requires a simple 3 wire serial communication link, transmit data, receive data, and signal ground. If using this method, when a device can no longer receive, it will transmit a character that the two devices agreed on. This character is known as the XOFF character. This character is generally a hexadecimal 13. When a device can receive again it transmits an XON character that both devices agreed to. This character is generally hexadecimal.

4.8.5 NULL MODEM-INTRODUCTION

Serial communications with RS232. One of the oldest and most widely spread communication methods in computer world. The way this type of communication can be performed is pretty well defined in standards. I.e. with one exception. The standards show the use of **DTE/DCE** communication, the way a computer should communicate with a peripheral device like a modem. For your information, **DTE** means *data terminal equipment* (computers etc.) where **DCE** is the abbreviation of *data communication equipment* (modems). One of the main uses of serial communication today where no modem is involved—a *serial null modem* configuration with **DTE/DTE** communication—is not so well defined, especially when it comes to flow control. The terminology *null modem* for the situation where two computers communicate directly is so often used nowadays, that most people don't realize anymore the origin of the phrase and that a null modem connection is an exception, not the rule.

In history, practical solutions were developed to let two computers talk with each other using a null modem serial communication line. In most situations, the original modem signal lines are reused to perform some sort of handshaking. Handshaking can increase the maximum allowed communication speed because it gives the computers the ability to control the flow of information. High amounts of incoming data is allowed if the computer is capable to handle it, but not if it is busy performing other tasks. If no flow control is implemented in the null modem connection, communication is only possible at speeds at which it is sure the receiving side can handle the amount information even under worst case conditions.

4.8.6 ORIGINAL USE OF RS232

When we look at the connector pinout of the RS232 port, we see two pins which are certainly used for flow control. These two pins are **RTS**, request to send and **CTS**, clear to send. With **DTE/DCE** communication (i.e. a computer communicating with a modem device) **RTS** is an output on the **DTE** and input on the **DCE**. **CTS** is the answering signal coming from the **DCE**.

Before sending a character, the **DTE** asks permission by setting its **RTS** output. No information will be sent until the **DCE** grants permission by using the **CTS** line. If the **DCE** cannot handle new requests, the **CTS** signal will go low. A simple but useful mechanism allowing flow control in one direction. The assumption is, that the **DTE** can always handle incoming information faster than the **DCE** can send it. In the past, this was true. Modem speeds of 300 baud were common and 1200 baud was seen as a high speed connection.

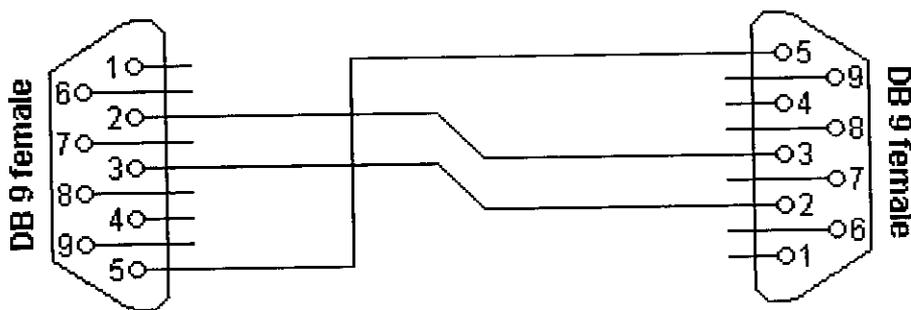
For further control of the information flow, both devices have the ability to signal their status to the other side. For this purpose, the **DTR** data terminal ready and **DSR** data set ready signals are present. The **DTE** uses the **DTR** signal to signal that it is ready to accept information, whereas the **DCE** uses the **DSR** signal for the same purpose. Using these signals involves not a small protocol of requesting and answering as with the **RTS/CTS** handshaking. These signals are in one direction only.

The last flow control signal present in **DTE/DCE** communication is the **CD** carrier detect. It is not used directly for flow control, but mainly an indication of the ability of the modem device to communicate with its counter part. This signal indicates the existence of a communication link between two modem devices.

4.8.7 NULL MODEM WITHOUT HANDSHAKING

How to use the handshaking lines in a null modem configuration? The simplest way is to don't use them at all. In that situation, only the data lines and signal ground are cross connected in the null modem communication cable. All other pins have no connection. An example of such a null modem cable without handshaking can be seen in the figure below.

Simple null modem without handshaking



Connector 1	Connector 2	Function
2	3	Rx ← Tx
3	2	Tx → Rx
5	5	Signal ground

4.8.8 COMPATIBILITY ISSUES

If you read about null modems, this three wire null modem cable is often talked about. Yes, it is simple but can we use it in all circumstances? There is a problem, if either of the two devices checks the **DSR** or **CD** inputs. These signals normally define the ability of the other side to communicate. As they are not connected, their signal level will never go high. This might cause a problem.

The same holds for the **RTS/CTS** handshaking sequence. If the software on both sides is well structured, the **RTS** output is set high and then a waiting cycle is started until a ready signal is received on the **CTS** line. This causes the software to hang because no physical connection is present to either **CTS** line to make this possible. The only type of communication which is allowed on such a null modem line is data-only traffic on the cross connected **Rx/Tx** lines.

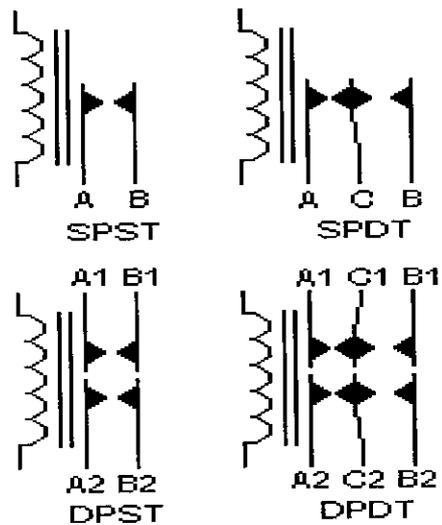
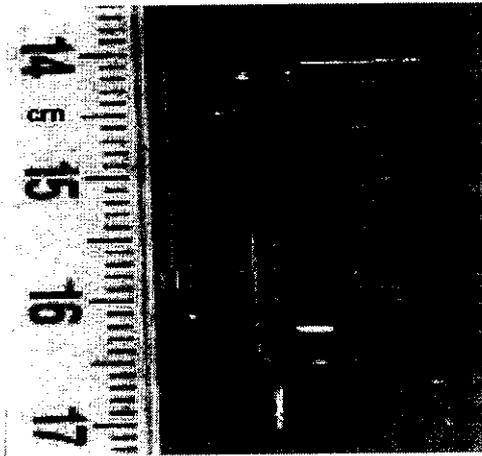
This does however not mean, that this null modem cable is useless. Communication links like present in the Norton Commander program can use this null modem cable. This null modem cable can also be used when communicating with devices which do not have modem control signals like electronic measuring equipment etc.

As you can imagine, with this simple null modem cable no hardware flow control can be implemented. The only way to perform flow control is with software flow control using the **XOFF** and **XON** characters

4.9 RELAY

4.9.1 INTRODUCTION

A relay is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts.



4.9.2 RELAY OPERATION

Diagram that a relay uses an electromagnet. This is a device consisting of a coil of wire wrapped around an iron core. When electricity is applied to the coil of wire it becomes magnetic, hence the term electromagnet. The A B and C terminals are an SPDT switch controlled by the electromagnet. When electricity is applied to V1 and V2, the electromagnet acts upon the SPDT switch so that the B and C terminals are connected. When the electricity is disconnected, then the A and C terminals are connected.

It is important to note that the electromagnet is magnetically linked to the switch but the two are NOT linked electrically

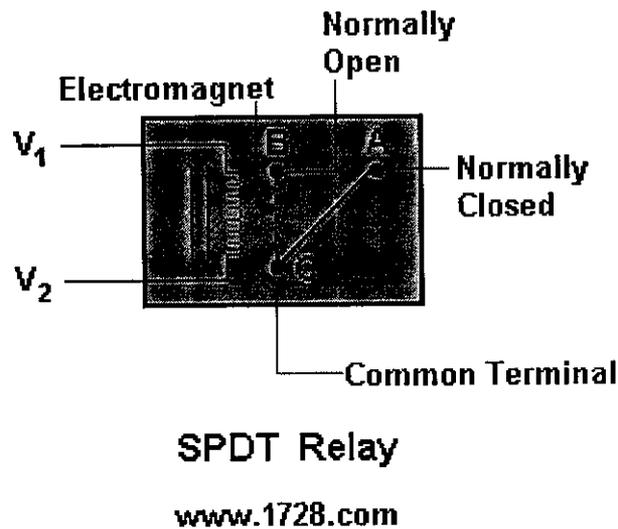


Figure 4.9.3 Relay Operation

4.9.3 POLE AND THROW

- Normally-open (NO) contacts connect the circuit when the relay is activated; the circuit is disconnected when the relay is inactive. It is also called a Form A contact or "make" contact.
- Normally-closed (NC) contacts disconnect the circuit when the relay is activated; the circuit is connected when the relay is inactive. It is also called a Form B contact or "break" contact.
- SPST - Single Pole Single Throw. These have two terminals which can be connected or disconnected. Including two for the coil, such a relay has four terminals in total. It is ambiguous whether the pole is normally open

or normally closed. The terminology "SPNO" and "SPNC" is sometimes used to resolve the ambiguity.

- SPDT - Single Pole Double Throw. A common terminal connects to either of two others. Including two for the coil, such a relay has five terminals in total.



Fig 4.9.4 VOLTAGE MEASUREMENT BLOCK

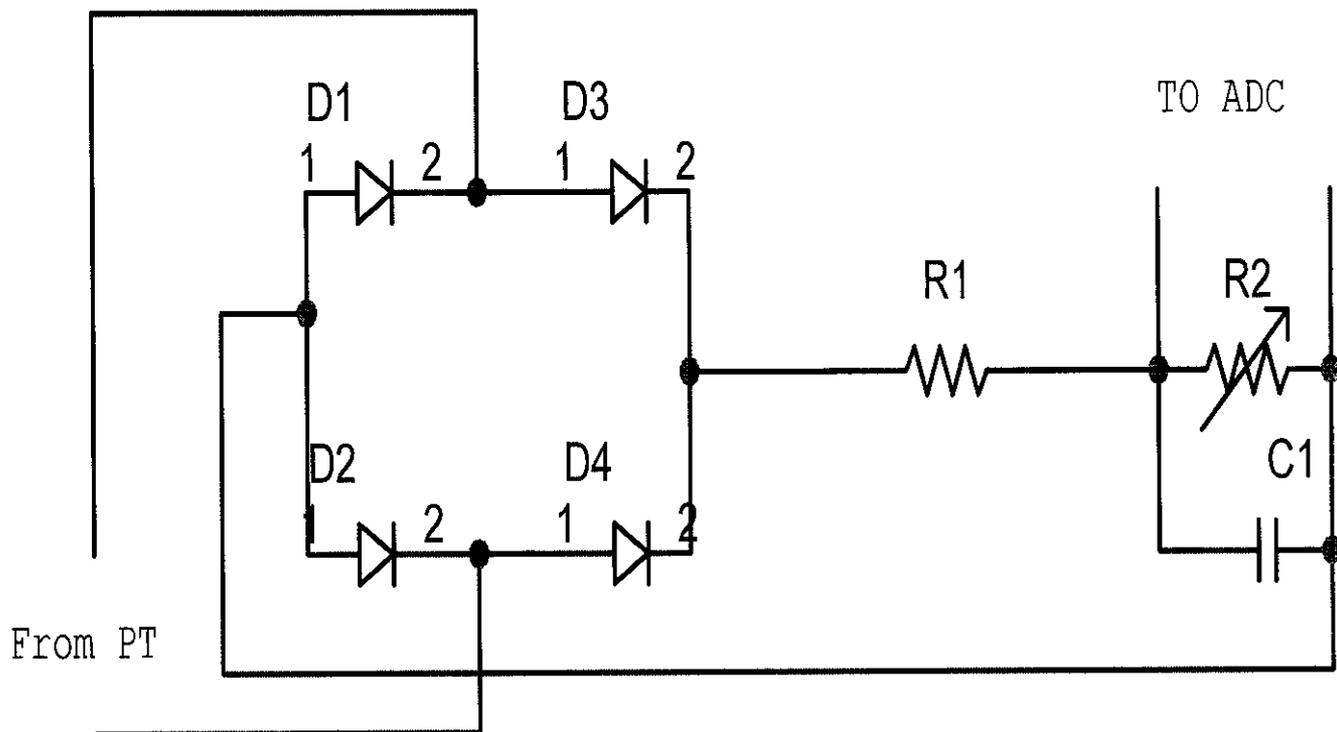
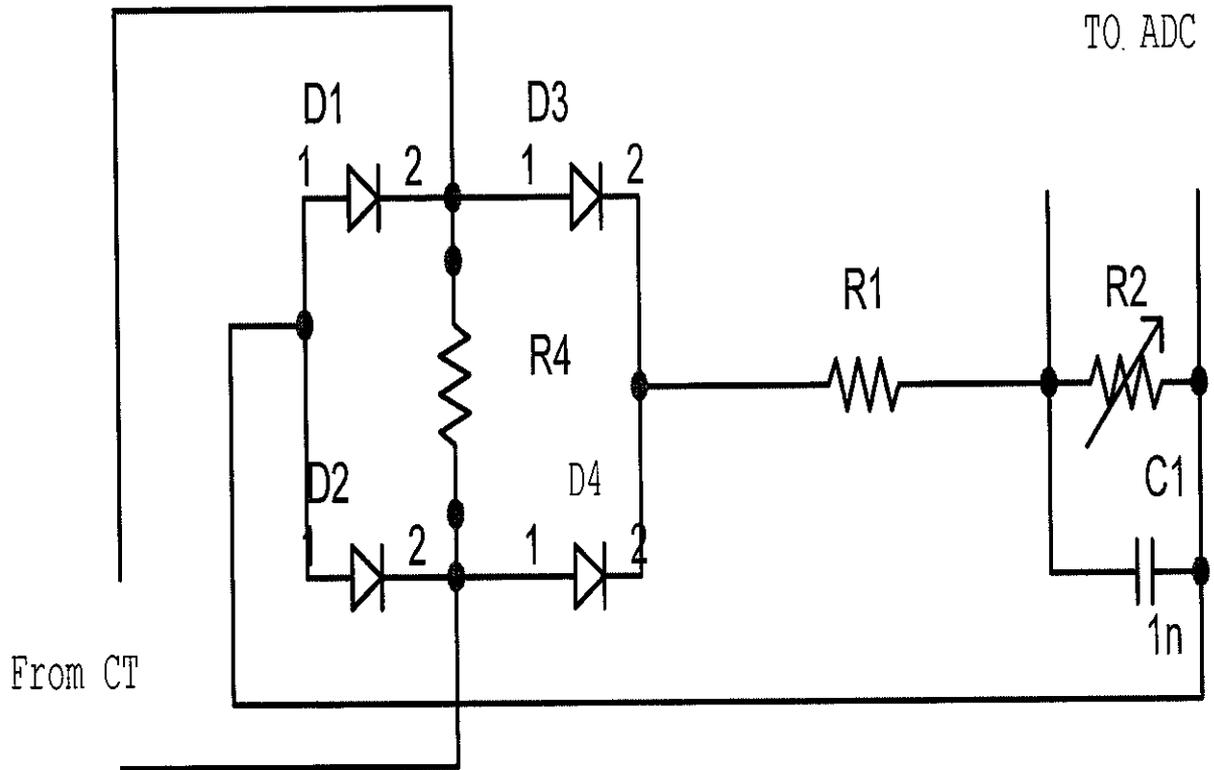


Fig 4.9.5 CURRENT MEASUREMENT BLOCK



4.9.6 SIGNAL CONDITIONING

Signal conditioning means manipulating an analogue signal in such a way that it meets the requirements of the next stage for further processing. For example, the output of an electronic temperature sensor, which is probably in the millivolts range is probably too low for an Analog-to-digital converter (ADC) to process directly. In this case the signal conditioning is the amplification necessary to bring the voltage level up to that required by the ADC.

4.9.7 AMPLIFICATION

Amplifiers boost input signal level to better match the analog-to-digital converter (ADC) range, thus increasing the measurement resolution and sensitivity. In addition, using external signal conditioners located closer to the signal source, or transducer, improves the measurement signal-to-noise ratio by boosting the signal level before it is affected by environmental noise.

4.9.8 ATTENUATION

Attenuation, the opposite of amplification, is necessary when voltages to be digitized are beyond the digitizer input range. the conditioned signal is within ADC range. Attenuation is necessary for measuring high voltages.

CHAPTER 5.

SOFTWARE REQUIREMENT

SOFTWARE REQUIREMENTS

5.1 Software tools

- MPLAB
- Protel
- Propic
- HI-Tech PIC C Compiler

5.2 MPLAB INTEGRATION

MPLAB Integrated Development Environment (IDE) is a free, integrated toolset for the development of embedded applications employing Microchip's PIC micro and dsPIC microcontrollers. MPLAB IDE runs as a 32-bit application on MS Windows, is easy to use and includes a host of free software components for fast application development and super-charged debugging. MPLAB IDE also serves as a single, unified graphical user interface for additional Microchip and third party software and hardware development tools. Moving between tools is a snap, and upgrading from the free simulator to MPLAB ICD 2 or the MPLAB ICE emulator is done in a flash because MPLAB IDE has the same user interface for all tools. MPLAB C30, targeted at the high performance PIC24 and dsPIC

digital signal controllers. Or, use one of the many products from third party language tools vendors. They integrate into MPLAB IDE to function transparently from the MPLAB project manager, editor and compiler.

5.3 INTRODUCTION TO EMBEDDED 'C'

Ex: Hitec – c, Keil – c

HI-TECH Software makes industrial-strength software development tools and C compilers that help software developers write compact, efficient embedded processor code.

For over two decades HI-TECH Software has delivered the industry's most reliable embedded software development tools and compilers for writing efficient and compact code to run on the most popular embedded processors. Used by tens of thousands of customers including General Motors, Whirlpool, Qualcomm, John Deere and many others, HI-TECH's reliable development tools and C compilers, combined with world-class support have helped serious embedded software programmers to create hundreds of breakthrough new solutions.

Whichever embedded processor family you are targeting with your software, whether it is the ARM, PICC or 8051 series, HI-TECH tools and C compilers can help you write better code and bring it to market faster.

HI-TECH PICC is a high-performance C compiler for the Microchip PIC micro 10/12/14/16/17 series of microcontrollers. HI-TECH PICC is an industrial-strength ANSI C compiler - not a subset implementation like some other PIC compilers. The PICC compiler implements full ISO/ANSI C, with the exception of recursion. All data types are supported including 24 and 32 bit IEEE standard floating point. HI-TECH PICC makes full use of specific PIC features and using an intelligent optimizer, can generate high-quality code easily rivaling hand-written assembler. Automatic handling of page and bank selection frees the programmer from the trivial details of assembler code.

5.4 EMBEDDED “C” COMPILER

- ANSI C - full featured and portable
- Reliable - mature, field-proven technology
- Multiple C optimization levels
- An optimizing assembler
- Full linker, with overlaying of local variables to minimize RAM usage
- Comprehensive C library with all source code provided
- Includes support for 24-bit and 32-bit IEEE floating point and 32-bit long data types
- Mixed C and assembler programming
- Unlimited number of source files
- Listings showing generated assembler
- Compatible - integrates into the MPLAB IDE, MPLAB ICD and most 3rd-party development tools
- Runs on multiple platforms: Windows, Linux, UNIX, Mac OS X, Solaris

5.5 EMBEDDED C TOOLS

5.5.1 Assembler

An assembler is a computer program for translating assembly language — essentially, a mnemonic representation of machine language — into object code. A cross assembler (see cross compiler) produces code for one type of processor, but runs on another. The computational step where an assembler is run is known as assembly time. Translating assembly instruction mnemonics into opcodes, assemblers provide the ability to use symbolic names for memory locations (saving tedious calculations and manually updating addresses when a program is slightly modified), and macro facilities for performing textual substitution — typically used to encode common short sequences of instructions to run inline instead of in a subroutine. Assemblers are far simpler to write than compilers for high-level languages.

Benefits of assembly language

Speed: Assembly language programs are generally the fastest programs around.

Space: Assembly language programs are often the smallest.

Capability: They can do things in assembly which are difficult or impossible in High level languages.

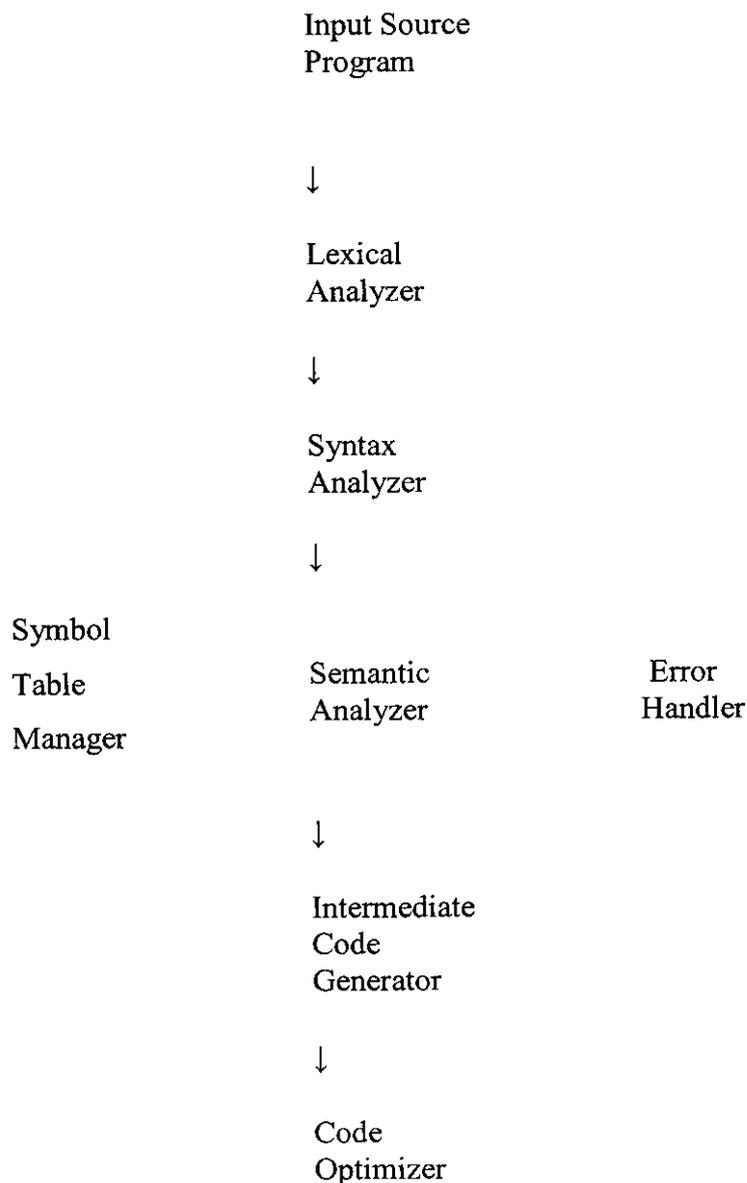
5.5.2 Compiler

A compiler is a program that reads a program in one language, the source language and translates into an equivalent program in another language, the target language. The translation process should also report the presence of errors

in the source program. There are two parts of compilation. The analysis part breaks up the source program into constant piece and creates an intermediate representation of the source program. The synthesis part constructs the desired target program from the intermediate representation

5.5.3 Phases of compiler

The compiler has a number of phases plus symbol table manager and an error handler



↓

Code
Generator

↓

Out Target
Program

5.6 Tools

Like typical computer programmers, embedded system designers use compilers, assemblers, and debuggers to develop embedded system software. However, they also use a few tools that are unfamiliar to most programmers.

Software tools can come from several sources:

- Software companies that specialize in the embedded market.
- Ported from the GNU software development tools.

Sometimes, development tools for a personal computer can be used if the embedded processor is a close relative to a common PC processor. Embedded system designers also use a few software tools rarely used by typical computer programmers. One common tool is an "in-circuit emulator" (ICE) or, in more modern designs, an embedded debugger. This debugging tool is the fundamental trick used to develop embedded code. It replaces or plugs into the microprocessor, and provides facilities to quickly load and debug experimental code in the system. A small pod usually provides the special electronics to plug into the system. Often a personal computer with special software attaches to the pod to provide the debugging interface. Another common tool is a utility program (often home-grown) to add a checksum or CRC to a program, so it can check its program data before executing it.

An embedded programmer that develops software for digital signal processing often has a math workbench such as MathCad or Mathematical to simulate the mathematics. Less common are utility programs to turn data files into code, so one can include any kind of data in a program.

5.7 ORCAD-PCB DESIGN.

The capability to provide fast and universal design entry makes orcad capture design entry the most widely used schematic entry system in electronic design today. Whether used to design a new analog circuit, revise a schematic diagram for an existing printed circuit board (PCB), or design a digital block diagram with an HDL module, orcad capture provides the tools needed to enter, modify, and verify the PCB design. Orcad Capture CIS integrates the Orcad Capture schematic design application with the features of a component information system (CIS).

5.7.1 ORCAD PCB DESIGN TECHNOLOGIES

ORCAD products have a proven track record of innovation in the PCB personal productivity market. Available as stand-alone tools or in comprehensive suites, they allow designers to realize products from conception to manufacturing output. Easy to use and intuitive, they offer exceptional value, and orcad technology provides easy migration to the platform.

5.7.2 ORCAD CAPTURE

ORCAD Capture is a complete solution for design creation, management, and reuse. Its ease-of-use allows designers to focus their creativity on design development rather than tool operation. The hierarchical Schematic

Page Editor combines a windows user interface with functionality and features specifically for design entry tasks and for publishing design data.

Centralized project management provides seamless interchange of schematic data for circuit simulation, board layout, and signal integrity analysis. A configurable design rule check (DRC) mechanism helps eliminate costly engineering change orders (ECOs). Basic bill of materials (BOMs) outputs are created from data schematic data for circuit simulation, board layout, and signal integrity analysis. A configurable design rule check (DRC) mechanism helps eliminate costly engineering change orders (ECOs). Basic bill of materials (BOMs) outputs are created from data contained in the schematic database.

5.7.3 ORCAD CAPTURE CIS

ORCAD capture CIS is designed to reduce production delays and cost overruns through efficient management of components. It reduces the time spent searching existing parts for reuse, manually entering part information content, and maintaining component data. Users search parts based on their electrical characteristics and orcad capture CIS automatically retrieves the associated part. Flexible and scalable, the solution is quickly implemented.

Orcad capture CIS is ideal for individual design teams or multi-site teams who need to collaborate across multiple locations, orcad capture CIS gives designers access to correct part data early in the design process and enables complete component specifications to be passed to board designers and other members of the design team, reducing the potential for downstream errors.

CHAPTER -7

CONCLUSION

This project was well planned by our team mates and our guide makes this project as a successful one by the effects of team mates and guide. a complete working prototype of the GAPMR system was built to demonstrate an Automatic power meter reading using GSM network. The GAPMR system takes the advantage of existing GSM infrastructure that have virtually full coverage of all housing and building area across the country which lead to low infrastructure implementation cost, simple and easy installation of GSM power meter at consumer side as GSM power meter is no difference from existing ordinary analogue or digital meter installation. The GAPMR system proven to provides effective ,reliable and efficient wireless automatic power meter reading and notification through the use of GSM network thus Reduce human operator meter reading operation cost.

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